TYPES PG-71 AND PG-71N PULSE GENERATORS

INSTRUCTION MANUAL

LYONS INSTRUMENTS

INSTRUCTION MANUAL

TYPES PG-71
AND PG-71N
PULSE GENERATORS

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Designed and manufactured in England by

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LYONS INSTRUMENTS • HODDESDON • HERTS • ENGLAND
PERIOD
DELAY(A)
WIDTH(A)
OUTPUT (A)
DELAY(B)
WIDTH(B)
OUTPUT (B)
EXT
SECS.
ON
A
A+B
B
B+A
SYNC. OUT
MANUAL
POWER
PG 71
PULSE GENERATOR

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POWER
PG 71N BIPOLAR
PULSE GENERATOR

CONTENTS

		Page
	Introduction	5
	Warranty	5
1	**Specifications**	6
2	**General Description**	7
3	**Description of Controls**	8
4	**Operating Instructions**	9
4.1	Mains Supply	9
4.2	External D.C. Operation (when fitted)	9
4.3	Setting Source Impedance	9
4.4	Check Operation	10
5	**Circuit Description**	11
5.1	General	11
5.2	Period Multivibrator	11
5.3	Shaper/Delay A	12
5.4	Shaper/Width A/B	13
5.5	Mixer	13
5.6	Output Stages	13
5.7	Power Supplies	13
6	**Calibration**	14
6.1	Power Supplies	14
6.2	Timing Circuits	14
6.3	Setting Output Source Impedance	15
7	**Applications**	16
7.1	General	16
7.2	Double Pulse — Independent Widths	16
7.3	Double Frequency Facility	16
7.4	True Double Pulse — Independent Amplitude	16
7.5	Narrow Pulse on Pedestal	17
7.6	Pulse Advance Capability	17
7.7	Bipolar Pulse Outputs	17
7.8	External Mixing	18
7.9	Generator Loads	18
8	**Maintenance**	19
8.1	General	19
8.2	Replacement Parts	19
8.3	Preliminary Investigations	19
8.4	Test Equipment Required	19
8.5	Block Schematic	19
8.6	Fault Location	20
9	**Diagrams**	22
9.1	Component Layout — PG-71	22
9.2	Circuit Diagram — PG-71	23
9.3	Circuit Diagram — PG-71N Negative Output Board	24
9.4	Component Layout — PG-71N Negative Output Board	24

INTRODUCTION

The Lyons Instruments Types PG-71 and PG-71N are all solid state Pulse Generators using TTL integrated circuits and silicon transistors throughout to provide true dual channel instruments and a new concept in flexibility. They are the forerunners of a new range of Pulse Generator equipment designed to satisfy all general purpose applications for industrial and educational environments.

A new packaging technique has been used employing basic modules which in themselves are complete powered instruments and hence may be used separately or as pairs in a dual width cabinet.

The component complement has been reduced to a minimum providing for high reliability, excellent accessibility and ease of servicing.

This handbook provides all the information and instructions to enable the user to obtain optimum performance and service from the instrument. If further information is required please contact the LI Engineering Department, who will be pleased to assist with any particular application requirements.

WARRANTY

Lyons Instruments Limited guarantees each instrument manufactured by us to be free from defects in material and workmanship for a period of one year from date of delivery to the original purchaser. Repair during this time will be made by us free of charge if the instrument is returned to our works carriage paid.

If an instrument is believed to be defective, please notify our Service Department, giving the model and serial number of the instrument, as well as a description of the nature of the fault. Our Service Department will then, if necessary, authorise the return of the instrument under the terms of this guarantee and advise how shipment should be made.

SECTION 1

SPECIFICATIONS

TYPES PG-71 AND PG-71N PULSE GENERATORS

Pulse Period	200 ns - 1 sec (p.r.f. 5 MHz - 1 Hz) single channel or combined outputs, in 7 decade ranges with logging vernier.
External Inputs	*Manual:* One-shot facility. *Gate:* DC - 1 MHz. *Ext. Drive:* DC - 1 MHz (Pulse input RT less than 30 μs/volt) *Sensitivity:* Gate and Ext., +2V into kΩ/100 pf.
Delay (Channel A)	Less than 50 ns - 1 sec (from sync. output trailing edge) in 8 decade ranges with logging vernier.
Delay (Channel B)	Less than 50 ns - 1 sec (from sync. output trailing edge) in 8 decade ranges with logging vernier.
Width (Channel A)	Less than 50 ns - 1 sec in 8 decade ranges with logging vernier.
Width (Channel B)	Less than 50 ns - 1 sec in 8 decade ranges with logging vernier.
Output (Channel A)	+0·5 to +10V from 50 ohms, or +0·5 to 10V into 50Ω by internal links.
Output (Channel B)	
(PG-71)	+0·5 to +10V from 50 ohms, or +0·5 to 10V into 50Ω by internal links.
(PG-71N)	±0·5 to 10V from 50 ohms, or ±0·5 to 10V into 50 ohms by internal links.
Rise and Fall Times	Less than 10 ns for both channels.
Duty Cycle	Greater than 50% in all modes. Greater than 90% in combined mode.
Sync. Output	+2V min. into 50Ω. Width 30 ns nominal.
Double Pulse	Double pulse facility achieved by use of channel combining switches (independent width and delay, equal amplitude) or external mixing (independent width, delay and amplitude).
Mains Supply	110/115/120/220/230/240V ±10%, 47 - 65 Hz, 15 watts maximum. External DC operation (when fitted) +24V ±2V 800 mA. PG-71N also requires −24V ±2V 400 mA when negative output required.
Net Weight	7½ lbs (3·4 kg).
Dimensions	9¼" × 3½" × 10⅞" overall (including handles) (235 × 90 × 276 mm).

Specifications unless otherwise stated are those of a typical instrument.

SECTION 2

GENERAL DESCRIPTION

The PG-71 and PG-71N are true double pulse generators having two independent delay, width and output channels driven from a common clock pulse generator. The output from both width generators may be combined by front panel toggle switches to provide double pulse operation on one or both output channels thus allowing one channel to operate at twice the repetition rate of the other as required. The PG-71 provides two positive channels whilst in the PG-71N the output polarity of channel B may be positive or negative as set by the toggle switch adjacent to B output socket. This facility allows either true positive-going double pulse operation or true bipolar operation when the outputs of each socket are combined via a resistive mixing network.

Each of the pulse timing functions has a separate calibrated control which allows the pulse parameters to be set approximately without use of external equipment and provides facilities for logging readings obtained when the instrument is used for qualitative measurements.

A sync output facility is provided on the front panel and external trigger and gate input sockets are fitted at the rear. A manual "one shot" push button is fitted adjacent to the sync output socket.

The instrument normally operates from mains supplies but modifications can be incorporated to allow operation from external 24 volts D.C. supply, when a changeover switch is fitted to the rear panel for supply selection. This also operates as the on/off switch for D.C. supply.

It should be noted that when a D.C. operated PG-71N is required to provide a negative output it is necessary to connect two independent 24 volt supplies at the rear terminals, one for positive and one for negative channel output.

Each output circuit is capable of driving up to 200 mA into 50 ohms and may be used in three basic modes:—

(1) 10 volts into High Impedance (50 ohm source)

(2) 5 volts into 50 ohms (50 ohm source)

(3) 10 volts into 50 ohms (Low Z source)

Access to the source impedance links can be obtained by removing the module from its case and locating linking pins adjacent to each output amplifier. Either channel may be changed and used as required but the instrument will normally be despatched from the factory with the 50 ohm source resistor fitted.

SECTION 3

DESCRIPTION OF CONTROLS

3.1 Power On Switch and Indicator

The power on switch connects A.C. supply to the transformer primary winding. For external D.C. supply see Section 4.2 and paragraphs 5.7.3 and 5.7.4. The Power ON indicator is a 28 volt filament lamp connected to the +17 volt rail to provide an indication of the ON condition regardless of the supply connected.

3.2 Period Range Switch and Vernier

The Range switch selects a pair of capacitors, one for each arm of the period multivibrator, to determine the decade range selection and the 10:1 vernier provides a fine control calibrated as a direct multiplier of Range setting. The fully 'clockwise' position of the switch is identified EXT and when selected the internal multivibrator is inhibited allowing the Manual pushbutton or EXT. TRIG. socket to control the Delay circuits.

3.3 Manual Push Button or EXT Trigger Socket

These two facilities are only available when the Period Range Switch is placed in the EXT condition. A positive going pulse greater than 2V at the EXT trigger socket or depressing the push button will initiate the Delay circuits.

3.4 Gate Input

This socket enables a gated output to be achieved by inhibiting the period multivibrator for as long as the input socket is at a greater potential than +2 volts.

3.5 Delay Range Switches and Verniers

Both A and B delay functions are identical, each providing 8 decade ranges by selecting a single capacitor in the timing monostable circuit. The verniers are fine controls calibrated 10 : 1 which may be used as a direct multiplier of the range setting. The function of these controls is to delay the output pulse on each channel by an amount equal to the respective dial setting, relative to the sync output.

3.6 Width Range Switches and Vernier

The controls are electrically similar to the delay system but determine the width of the output pulses produced.

3.7 Amplitude Controls

Each control forms a simple attenuator across its respective output channel allowing a full range control of 0·5 to 10 volts EMF.

3.8 Channel Combining Switches

Each channel has its own combining switch which allows an effective cross-coupling before the output stages. With either switch to single channel working the output on that channel will be a pulse determined only by the related delay and width functions but in the combined positions both channel pulses will be available in serial form on the applicable output socket. The pulse pairs produced may each be controlled independently in width and delay, i.e. true double pulse. (See application notes — section 7).

3.9 Output Sockets

Three output sockets are provided as follows:—

	PG-71	PG-71N
(a) **Sync Output**	+2 volts into 50 ohms	+2 volts into 50 ohms
(b) **A Output**	+10 volts from 50 ohms (see Section 6.3.1)	+10 volts from 50 ohms (see Section 6.3.1)
(c) **B Output**	+10 volts from 50 ohms (see Section 6.3.2)	±10 volts from 50 ohms (see Sections 6.3.2. & 6.3.3.)

3.10 Polarity Switch — PG-71N only

This toggle switch is fitted adjacent to the Channel B output socket and allows the B output pulse to be set either positive (+) or negative (−) going from 0 volts.

SECTION 4

OPERATING INSTRUCTIONS

4.1 **Mains Supply**

The instrument is despatched from the factory with internal source resistors connected in circuit and mains links set to 240V 50Hz operation. unless otherwise stated.

Disconnect unit from any external supply, remove module from case and observe mains input transformer fitted to rear panel. The transformer has two primary windings each providing taps at 110, 115 and 120V., which should be connected as follows:—

4.1.1 110-120V Operation (see note 1)

Connect both primaries in parallel at selected level to suit mains requirements.

4.1.2 220-240V Operation (see note 1)

Connect primaries in series, i.e. link required high level terminal of Primary 1 to 0V of Primary 2 and connect line input (brown) to required high level terminal on Primary 2.

Note 1 — On type PG-71N additional links are fitted on the negative printed circuit board:—

For 230V operation Link P4, P5.

For 115V operation Link P3, P4 and P5, P6.

4.2 **External D.C. Operation (when fitted)**

WARNING — GROUNDED SUPPLIES WILL CAUSE DAMAGE TO INTERNAL CIRCUITS IF INCORRECTLY CONNECTED.

4.2.1 PG-71.

Connect EXT D.C. 24V supply to terminals provided observing correct polarity, i.e. —

D.C. Positive to RED Terminal

D.C. Negative to BLACK Terminal (grounded)

4.2.2 PG-71N.

As channel B may be switched positive and negative it is necessary to supply two independent D.C. supplies as follows:—

Positive Channels:

D.C. Positive to RED terminal

D.C. Negative to BLACK terminal (grounded)

Negative Channel:

D.C. Positive to BLACK terminal (grounded)

D.C. Negative to BLUE terminal

4.2.3 Place A.C./D.C. switch (rear panel) to D.C. Check pulse generator operation as in para. 4.4.

4.3 **Setting Source Impedance**

Disconnect power supply and remove module from case. Locate link connection pins (3 off) adjacent to each output amplifier and connect links as in the following table:

Source Z_O	Load Z_L	Channel A Link	Channel B Link	Channel B Neg. Ampl Link PG-71N	Volts Across Z_L
50Ω	500Ω Min.	P31 to P30	P26 to P25	P11 to P12	9 volts min.
50Ω	50Ω	P31 to P30	P26 to P25	P11 to P12	5 volts min.
LOW	50Ω	P29 to P30	P24 to P25	(See 6.3.3.)	10 volts min.

4.4 **Check Operation**

4.4.1 Connect instrument to a suitable mains supply (set supply links if necessary. See section 4.1).

4.4.2 Connect BNC-BNC cables from the SYNC and Channel A output sockets to oscilloscope trigger and Y input, respectively.

4.4.3 Set Pulse Generator as follows:

Range Switches	3rd switch position clockwise (10 μs period; 1 μs delays and widths).
Range Verniers	3
Amplitude Controls	Maximum
Combine Switches	Up
± Switch (PG-71N only)	Up

4.4.4 Set oscilloscope to display a time base approximately 5 μs/cm and observe Channel A output on CRT.

Check the pulse as follows:—

Amplitude:— Greater than +10 volts (some overshoot will be present with line unterminated).

On PG-71N check Channel B output changes to −10 volts when Polarity switch set to negative (−)

Period 30 μs approximately.

Delay 3 μs approximately.

Width 3 μs approximately.

Return Polarity Switch to positive (+).

4.4.5 Depress combine switch A and observe Channel B pulse is coincident with A. Verify by increasing Delay B vernier to 6 and note width is now approx. 6μs. Return Delay B vernier to 3.

4.4.6 Monitor output on Channel B socket, check as for 4.4.4 and 4.4.5 using Channel B combine switch and delay A vernier.

4.4.7 Return combine switches to the single channel condition and check all pulse generator ranges and verniers as required.

N.B. — At minimum range setting timing functions will not operate when set significantly below specification limits.

4.4.8 Set oscilloscope time base to 100μs/cm and Delay range switch to 0·1 μs.

Set width A to 0·1 ms and switch period switch to EXT. Check operation of manual push button.

4.4.9 Connect output from oscilloscope calibrator to EXT input socket on rear panel. Set calibrator amplitude to 5 volts — check pulse generator operation on both channels.

Re-check operation with calibrator set at 2 volts.

4.4.10 Connect calibrator output to gate socket, check delay is at approximately 0·1 μs and Period Switch to 10 μs range. Set width switches to 1 μs and both verniers to 5. Check gated waveform is present on oscilloscope.

N.B. — For checks 9 and 10 it is advisable to trigger the oscilloscope direct from the calibrator output and **not** the normal pulse generator sync output.

SECTION 5

CIRCUIT DESCRIPTION

5.1 General

The circuits used in the PG-71 and PG-71N have been derived as simply as possible, consistent with the performance requirements and practically all pulse timing functions are built around 74 series TTL integrated circuits. Discrete silicon semiconductors have been used only where necessary i.e. the output stages and for interfacing to external levels.

5.1.1 Block Diagram (Fig. 5.1)

The system period is determined either by the period generator, a multivibrator circuit described in 5.2, which can be gated by an inhibit signal to SKT1 (GATE input); by a manual one-shot push button PB1; or by an external trigger signal to SKT2 (EXT input).

These signals feed via a pulse shaper to the sync. output amplifier and delay monostables (Channels A and B). Each delay output is then coupled via a shaper to the respective width monostable.

The Channel A width monostable is connected permanently via Mixer A to drive the Channel A output amplifier (similarly for Channel B). Mixer (channel combining) switches enable the output of Channel B width generator to be fed into the Channel A output stage and/or vice versa. As will be seen later, these combining switches enable true double pulse outputs with independent delay and width settings, or one channel to operate at twice the PRF of the other.

The following paragraphs describe each section of the circuitry of the PG-71 and PG-71N in greater detail. (See circuit diagrams at rear).

5.2 Period Multivibrator

The basic multivibrator consists of only two NOR Gates (A1 and A3) and transistors Q4 and Q5. The gates are cross-coupled via capacitor networks and form an astable multivibrator with transistors Q4 and Q5 in the feedback paths to ensure correct switching throughout the 10 : 1 range of the vernier control. Gate A2, Diodes D8 and D9 and Gate A4 are connected as an Exclusive OR function to monitor the collector states of A1 A3 and ensure that the basic multivibrator starts under all operating conditions. Fine control of the period multivibrator is provided by RV2 and its range expansion preset RV1 RV3 which control the discharge rate of the multivibrator timing capacitors. Preset RV3 provides an effective "set minimum" control when calibrating the period vernier.

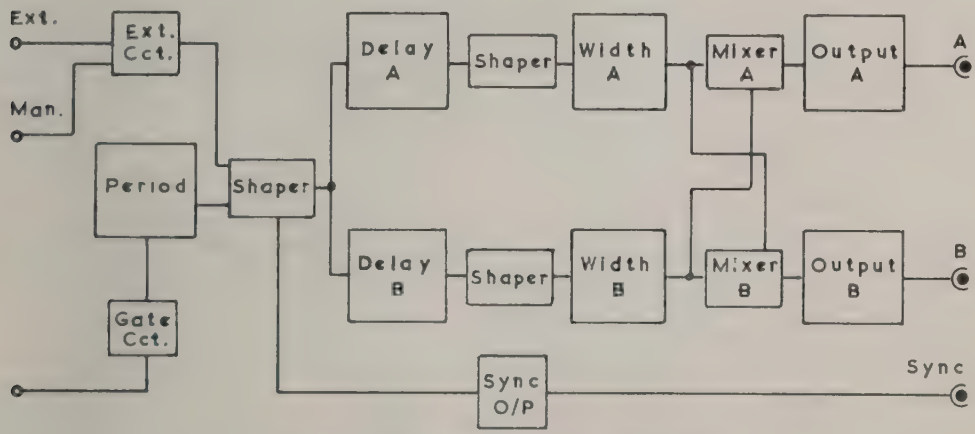


FIG. 5.1 — PG-71 BLOCK CIRCUIT DIAGRAM

5.2.1 Gate Circuit

The gating circuit allows the clock to be inhibited by a signal of +2V or greater to the base of Q2 via SKT1 on the rear panel. The input pulse is coupled via Q2 and Q3 to inhibit the period multivibrator at pin 9 of Gate A3 and via D7 to disable the starting circuit A2, A4, D8, D9.

Diodes D4, D5, D6, protect the gate input circuit against excessive input levels by limiting the base of Q2 to approximately 2·5 volts. The maximum permissible input level is 20 volts D.C. equivalent.

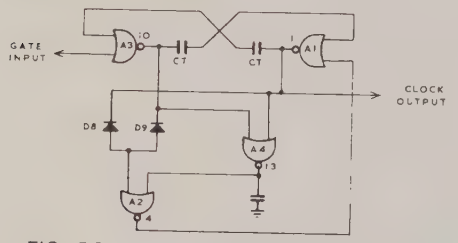


FIG. 5.2 — SIMPLIFIED MULTIVIBRATOR

5.2.2 External Input

External trigger signals may be applied to SKT1 in the form of positive going pulses of amplitude 2V or greater. Q1 acts as a buffer and passes the trigger pulses via C19 to the shaper network. Diodes D1, D2, D3 protect the external input circuits in a similar way to D4, D5, D6 in the gate circuit. Input signals must however, not exceed 20 volts D.C. equivalent.

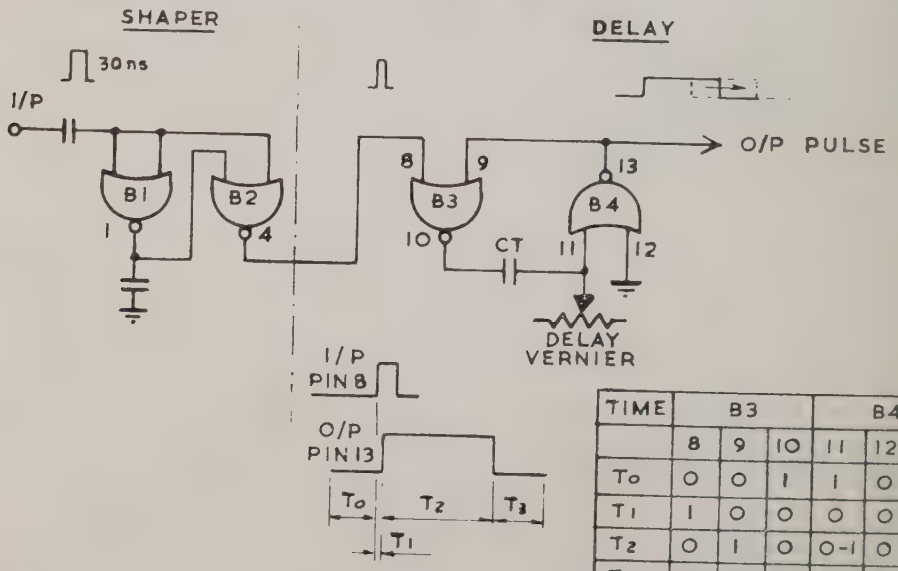
5.2.3 Manual one-shot

Push-button PB1 provides a 'one-shot' facility and when pressed a trigger pulse is passed via C22 to shaper A thus initiating a single complete operating cycle of the two main pulse output channels and sync output.

5.3 **Shaper/Delay A**

The output of the period multivibrator, Gate A1 is coupled via C20 to a shaping network comprising gates B1 and B2 as also are the output of the trigger buffer Q1 via C19 and the manual one-shot circuit via Q22. A short (30 ns approx.) positive going pulse is produced at the collector of gate B2 each time the input to B1 falls to 0·8 volts or less, the length of the pulse being determined by the propagation delay of the gates and capacitor C21. The positive pulse is used as the datum pulse for the two channel delay generators and the sync output emitter follower Q6.

The delay (A) multivibrator is formed by gates B3 and B4 coupled as a monostable via one of the coarse range capacitors C25 to C32. RV5 and its associated limit trimmers RV4 and RV6 provide a fine delay adjustment by controlling the discharge rate of the selected range capacitor.



TIME	B3			B4		
	8	9	10	11	12	13
To	0	0	1	1	0	0
T1	1	0	0	0	0	1
T2	0	1	0	0-1	0	1
T3	0	0	1	1	0	0

FIG. 5.3 — SIMPLIFIED SHAPER/DELAY

5.4 **Shaper/Width A/B**

The output of Delay A (pin 13) is fed via C41 to a second shaper employing gates C3, C4 which provides a correctly shaped firing pulse for the Width monostable C1 C2 coincident with trailing edge of the Delay output pulse. The Width monostable is formed by gates C1, C2 and timing capacitors C43 to C50. Fine Width control is provided by RV8 with presets RV7 and RV9 as its calibration trimmers.

The operation of the Shaper/Width circuitry is similar to that given in Fig. 5.3.

Gates E3, E4 similarly form a shaper feeding channel B width generator E1, E2.

The outputs of the two width generators are connected via the mixing circuit (para. 5.5) to the two output stages (para. 5.6).

5.5 **Mixer**

Gates D1. D2 are used to form a channel mixing circuit. One input of gate D1 is permanently connected to the A signal path and the other is connected either to ground (A) or B width generator output (A+B) by front panel switch (SW7).

Similarly SW6 is used to connect the A width generator output to mixer D2 in the B+A condition. These switches may be used to provide true double pulse operation on either channel independently or simultaneously as required.

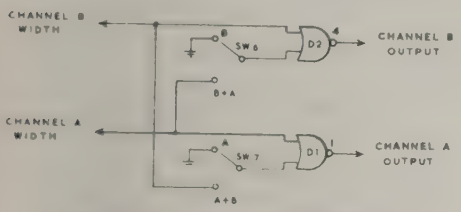


FIG. 5.4 — SIMPLIFIED MIXER

5.6 **Output Stages**

5.6.1 Output Stages PG-71

Two identical output amplifiers are used each comprising a simple current switch Q10 (or Q11) driving parallel emitter followers Q7 to Q9 (Q12 to Q14) to provide the necessary current drive to the output load (200 mA). For maximum flexibility, the source impedance R36 (R37) may be disconnected by removing the internal link L1A (L1B) as required and reconnecting the short across L2a (L2b) (see Section 6) Diodes D10, D11 provide reverse voltage protection. Care should be taken to ensure that any reverse current does not exceed 40 mA.

5.6.2 Output Stages PG-71N

The positive polarity outputs are the same as those used in Type PG-71 (see above) but an additional output amplifier is provided on a separate printed circuit board for negative pulse operation. The circuit comprises a level changer and inverter Q1 followed by a simple current switch and emitter followers Q3 to Q5 inclusive. In order to accommodate the source impedance change-over facility it is necessary to add or delete the link P11 to P12 and change the output connection from P13 to P11 respectively.

5.7 **Power Supplies**

5.7.1 Power Supplies PG-71

MR1 - MR4 form the bridge rectifier providing approximately 24 volts to the stabiliser circuits. Q15, D12 regulate the high level supply at +17V and D13 the 5·4 volt lines for use on all timing circuits.

5.7.2 Power Supplies PG-71N

All positive supplies are identical to the PG-71 but the negative supplies are derived on the negative output P.C. Board itself. A separate transformer is fitted to provide approximately 17 volts r.m.s. to the regulator circuit QM1 which provides the −12 volts Vce required for the negative output amplifier. Links P7 - P10 inclusive are provided for factory use only and in this application P7 should be permanently linked to P8 and P9 to P10.

5.7.3 External DC Operation PG-71

Some models may be fitted with an External DC facility to enable operation of the pulse generator from an external DC supply or battery and may be recognised by a pair of terminals RED (+), BLACK (−) and an AC/DC change-over switch fitted on the rear panel. The external DC (24V ±2V) supply may be connected to the terminals and the switch placed in the DC position. The "Power On" lamp is operated from the 17V DC rail and indicates in both AC and DC operation.

5.7.4 External DC Operation PG-71N

An additional DC input terminal (blue) may be fitted which allows −24 volts to be fed to the negative output amplifier.

WARNING — The operator should note that the BLACK terminal is connected to the instrument main ground and wrong connection or use of grounded DC supplies can cause damage to the internal circuits.

SECTION 6

CALIBRATION

6.1 Power Supplies

No presets are fitted or necessary. Check supplies with a Model 8 Avometer or equivalent as follows:—

C63 positive ... +17 volts ±1·5 volts
Pin 14 ... ... +5·4 volts ±0·75 volts
(PG-71N only) Pin 9 −17 volts ±1·5 volts

6.2 Timing Circuits

The vernier controls of the PG-71 are fitted with readout dials indicating 1 - 10 (usable), these are intended to be used principally as logging dials but an approximate calibration is provided by setting the internal adjustment trimmers as described below.

The dial reading is a direct multiplier function of the appropriate range switch setting (assuming all switch settings are compatible) and when calibrated in accordance with this section will allow setting of each function within approx. ±1 dial division.

Before making any internal adjustments the positioning of the control knobs should be capable of adjustment from less than 1 to greater than 10.

If any knob is out of position, remove the cap insert, release the collet fixing screws and remove the knob from the shaft. Set the potentiometer fully anticlockwise and replace the knob in a position equivalent to a dial reading of 0·5 approximately. Tighten the collet screw and check vernier can be adjusted to read approximately 10·5 in the fully clockwise position.

Circuit	Period	Delay A	Delay B	Width A	Width B
Set Min (1)	RV3	RV4	RV10	RV7	RV13
Set Max (10)	RV1	RV6	RV12	RV9	RV15

Table 6.1

6.2.1 Connect PG-71 to a dual beam oscilloscope triggered from the sync output socket and terminate all lines in 50 ohms. If a dual beam oscilloscope is not available A and B should be adjusted separately.

6.2.2 Set oscilloscope amplifier to 5V/cm and time base to 2 μs/cm. Set PG-71 range switches to the third position clockwise — period 10μ, delays and width 1μ — and all verniers to 5. (On PG-71N, set B Channel polarity switch to +).

6.2.3 Each trace will display a 10 volt positive going pulse approximately 5 μs duration and occurring approximately 5 μs after trace start. Increase delay verniers to 10 and adjust RV6 and RV12 until the displayed pulses (A and B respectively) occur 10 μs after trace start.

6.2.4 Reduce Delay Vernier to 1 and adjust RV4 and RV10 (A and B respectively) until pulses occur 1 μs after trace start.

Repeat 6.2.3 and 6.2.4 until both conditions are met.

Set Delay Verniers to 1 on completion.

6.2.5 Set Width Verniers to 10 and adjust RV9 and RV15 (A and B respectively) for displayed pulse width of 10 μs approx.

6.2.6 Reduce Width Verniers to 1 and adjust RV7 and RV13 (A and B respectively) for displayed pulse widths and 1 μs approx.

Repeat 6.2.5 and 6.2.7 until both conditions are met. Set Width Verniers at 3.

6.2.7 Set oscilloscope horizontal time base to display 10 μs/cm. Set Period Vernier to 10 and adjust RV1 until only 2 pulses are visible on each trace and period is approximately 100 μs.

6.2.8 Reduce Period Vernier to 1 and adjust RV3 until period between pulses is approximately 10 μs (expand oscilloscope time base to 1 μs/cm if required).

6.2.9 Repeat 6.2.7 and 6.2.8 until the Period Vernier tracks correctly.

6.2.10 Check PG-71 calibration on all other ranges using suitable oscilloscope settings and taking care that Pulse Generator settings are compatible before making any internal adjustment.

Note — As only one set of trimmers are fitted in each timing circuit it may be necessary to compromise on the setting of a particular range in order to set all other ranges within ±1 dial division.

6.3 Setting Output Source Impedance

6.3.1 Output A

(a) **10 volts into 50 ohms**

Remove shorting link from terminals P30-P31 (L1b) and replace with link across terminals P29-P30 (L2b).

(b) **10 volts from 50 ohms**

Remove shorting link from terminals P29 - P30 (L2b) and replace with link across terminals P30 - P31 (L1b).

6.3.2 Output B (Positive)

(a) **10 volts into 50 ohms**

Remove shorting link from terminals P25 - P26 (L1a) and replace with link across terminals P24 - P25 (L2a).

(b) **10 volts from 50 ohms**

Remove shorting link from terminals P24 - P25 (L2a) and replace with link across terminals P25 - P26 (L2a).

Note — On some units the source impedance links have been designated as follows:

Output A

P29 was af
P30 was ae
P31 was ad

Output B

P24 was Z
P25 was aa
P26 was ab

6.3.3 Output B Negative (PG-71N only)

(a) **10 volts into 50 ohms**

Remove shorting link from terminals P11 and P12. connect output lead (grey) to pin 11.

(b) **10 volts from 50 ohms**

Remove output lead from pin 11 and connect to pin 13. Connect shorting link across terminals P11 and P12.

SECTION 7

APPLICATIONS

7.1 The PG-71 is an extremely versatile instrument having external trigger and gate facilities and two channels with independent delay width and amplitude controls. These, and the mixing facilities provided, enable many pulse configurations to be obtained which have previously only been available with two or more instruments or expensive modular systems. In the following paragraphs some of the capabilities of a single PG-71 are described and for more complex functions two PG-71s can be provided in a 17½" rack-mounting cabinet.

7.2 Double Pulse — Independent Widths

It is often required to obtain a train of double pulses, the widths of each pulse being independently variable. This can be carried out with the PG-71 by the use of the channel mixing facilities (Sections 3.8 and 5.5). Waveforms obtained are shown in figure 7.1. It will be seen that when this facility is used, the delay and width of the added pulse are determined independently but both pulses at a given output have the same amplitude.

7.3 Double Frequency Facility

7.3.1 For checking IC counters and dividers it can be useful to produce two simultaneous pulse trains, one at double the p.r.f. of the other. This can be achieved if one channel is operated in the combined mode and the other in the single pulse mode, with both widths the same and the delays adjusted to produce equal pulse spacing, i.e. similar to Fig 7.1 outputs A and B + A but delay B adjusted for equal spacing.

7.3.2 To achieve this, proceed as follows:—

To obtain Channel A output at f simultaneously with Channel B output at 2f

(a) Set period to 1/f
(b) Set widths A and B to the same setting (must be less than ¼ of the period)
(c) Set delay A to 50 ns and delay B to half the set period + 50 ns
(d) Set Channel A mixer switch to 'A' and Channel B to 'B + A'.

The amplitudes of the two pulse trains are adjustable independently.

7.4 True Double Pulse—Independent Amplitude

By the use of an external mixer the outputs of the two channels may be combined to produce a **true double pulse mode** comprising pairs of pulses each of which is independently adjustable in amplitude as well as delay and width. Figure 7.2 shows a suitable mixing circuit (output impedance links should be set for 10 volts from 50 ohms when using this circuit (see Section 6). Figure 7.3 demonstrates the difference between internal mixing, using the channel mixing switches, and external mixing which adds independent amplitude facility.

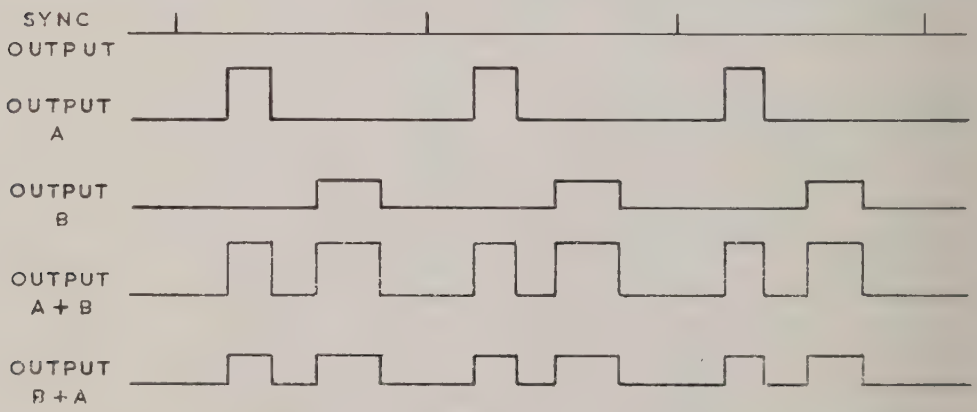


FIG 7.1

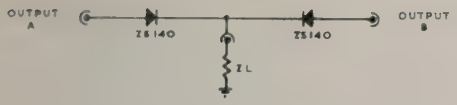


FIG. 7.2 — EXTERNAL MIXING (PG-71)

Alternative mixing circuits are possible and are discussed in section 7.8 below.

7.5 Narrow Pulse on Pedestal

This is a special variant of para. 7.4 and demonstrates the flexibility provided by the availability of two independent pulse timing channels. Figure 7.4 demonstrates the ability to combine a narrow high amplitude pulse occuring during the generation of a wide pulse of lower amplitude by suitable adjustment of the front panel controls.

7.6 Pulse Advance Capability

For certain applications a pulse advance capability is desirable. This is obtained very simply in the PG-71 by using one of the two main outputs as an effective sync output and the other as the main pulse output. If the main pulse output is set at minimum delay then the delay setting of the other channel provides the necessary pulse advance.

7.7 Bipolar Pulse Outputs (PG-71N only)

This is a variation on the conditions of 7.4 above. Channel B may be switched to provide a negative pulse output and the two channels mixed provided a resistive mixing network similar to Fig. 7.5 is used (see Section 7.8).

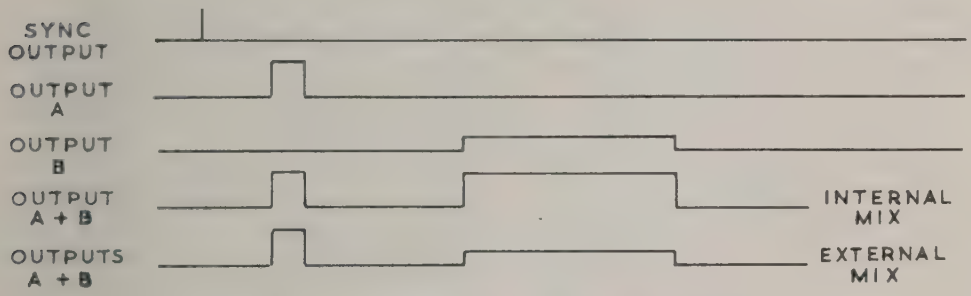


FIG. 7.3 — TRUE DOUBLE PULSE OPERATION

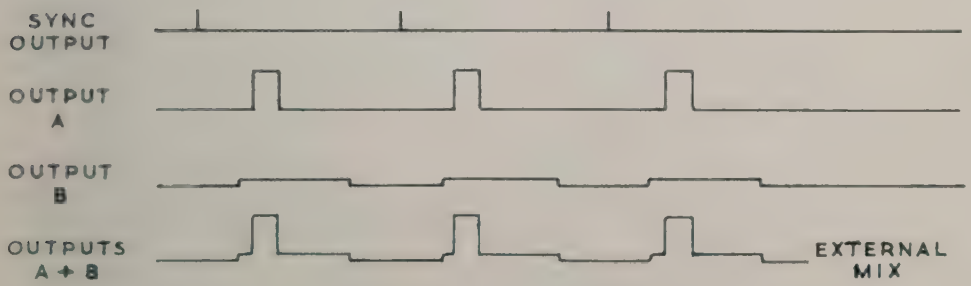


FIG. 7.4 — PULSE ON PEDESTAL

7.8 **External Mixing**

7.8.1 Diode Mixers (Fig. 7.2)

The diode mixing circuit shown in Fig. 7.2 should only be used for combining two positive channels, e.g. PG-71. The diode response will degrade pulse shape slightly, but allows virtually full amplitude pulses to be produced across the load, e.g. typically 9 volts into 50Ω.

7.8.2 Resistive (Bipolar) Mixers (Figs. 7.5a and 7.5b)

The resistive networks of Figs. 7.5a and 7.5b, unlike the diode mixer (Fig. 7.2) allow both unipolar and bipolar mixing but have the disadvantage of reducing pulse amplitude to approximately half that of the source.

The network shown in Fig. 7.5a is primarily intended for use with open-ended outputs, i.e. PG-71 or PG-71N with source resistors disconnected. The delta network shown in Fig. 7.5b is essentially similar to Fig. 7.5a, having the same advantages and disadvantages as far as mixing capability and effect on pulse amplitudes are concerned, but generally presents a better impedance match when used with back-terminated pulse sources.

Resistive mixers to the circuit of Fig. 7.5b (often described as matched 50Ω BNC signal splitters, power dividers, or the like) are available from various sources and may prove more convenient than making up the circuit from individual components.

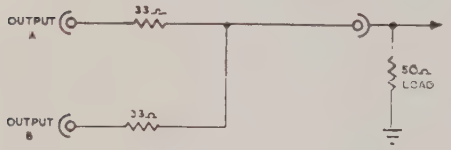


FIG. 7.5a — TYPICAL MIXING CIRCUIT FOR USE WITH LOW Z SOURCE

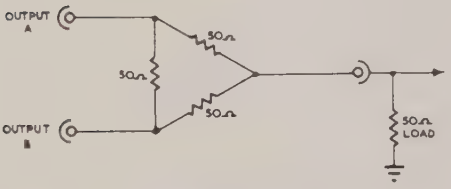


FIG. 7.5b — TYPICAL MIXING CIRCUIT FOR USE WITH 50 OHM SOURCE

7.9 **Generator Loads**

The PG-71 is designed to feed 50 ohm resistive loads from:—

(1) A 50 ohm source when the output is limited to 100 mA.

(2) A low impedance source when the output will deliver 200 mA into 50 ohms.

For optimum pulse shape all output connections should be via 50 ohm coaxial cable terminated by a good quality 50 ohm load. When driving active loads such as transistors suitable stand-off resistors should be employed and **UNDER NO CIRCUMSTANCES MUST THE CURRENT FED BACK TO OUTPUT SOCKET EXCEED 40 mA.**

SECTION 8

MAINTENANCE

WARNING

The PG-71 series instruments have been designed so that the mains supply must be disconnected before the module can be withdrawn from its case. However if the mains supply is re-connected to the unprotected module, care must be taken to avoid contact with the exposed terminals carrying mains voltages, i.e., 250V A.C.

In the case of type PG-71N, 250V A.C. is also present on the right hand printed circuit board.

8.1 GENERAL

This section provides general guidance on fault location and should enable the Service Engineer to isolate the fault to a main circuit function before resorting to the use of test equipment.

For detailed fault analysis the circuit diagrams and component layouts will provide all the necessary data to locate and replace a faulty component.

8.2 REPLACEMENT PARTS

All electronic components used are readily available from the manufacturers or one of the recognised distributors, but in the event of any difficulty a full stock of parts is held at our works in Hoddesdon and can normally be supplied by return. Plug-in TTL Integrated Circuits have been used and any equivalent to type SN 7402 may be used.

8.3 PRELIMINARY INVESTIGATIONS

Before suspecting a fault on the unit a thorough check should be carried out to ensure that the following are correct:—

(1) All interconnecting leads are sound and properly connected.

(2) The correct termination is being used, e.g. 50Ω and that these have not been damaged through overload or mishandling.

(3) That all range switches and verniers are adjusted to a point that is compatible with the main period setting. A good guide to this is to check that neither Width nor Delay range switch are set more clockwise than the Period range switch.

8.4 TEST EQUIPMENT REQUIRED

(1) Model 8 Avometer or equivalent D.C. multimeter.

(2) Oscilloscope with vertical bandwidth of 50 MHz.

(3) Oscilloscope probe (Z_{IN} - 1 MΩ).

(4) Terminations and Coaxial leads as required.

8.5 BLOCK SCHEMATIC

The diagram is repeated on p. 20 for convenience and will enable the Service Engineer to carry out a logical fault location procedure and isolate the fault to a major circuit function, often without removing the module from its case.

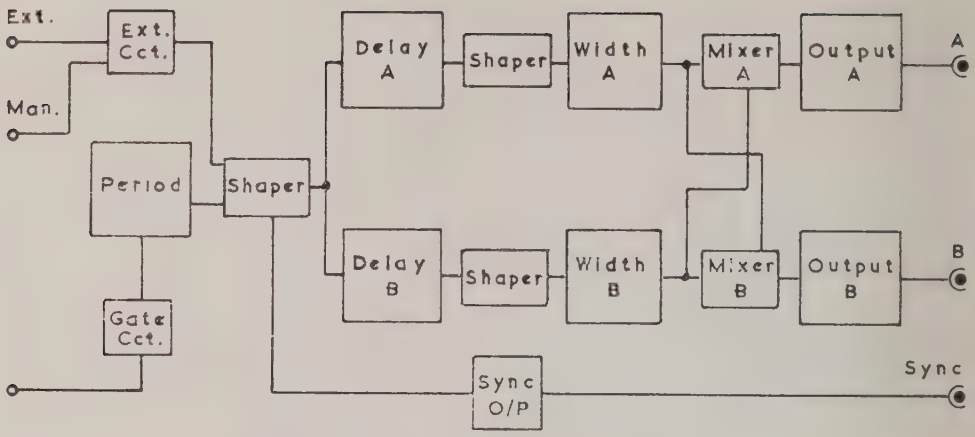


FIG. 8.1 — PG-71 BLOCK CIRCUIT DIAGRAM

8.6 FAULT LOCATION

Before removing the instrument from its case an attempt should be made to isolate the fault to a main circuit function using the block schematic.

The following table gives some simple verification tests that will be useful in any subsequent fault location work. The table assumes the unit to be operating from mains supply and applies to type PG-71 and PG-71N unless stated otherwise.

Set the controls as in para. 4.4.3 and check the facilities listed in Column 1 in turn, noting which of these are satisfactory or otherwise. On completion use Column 2 to deduce which main circuit functions require further investigation, then finally use Column 3 to identify the appropriate defective component or circuit.

1. Check Function	2. Circuit Tested	3. Test If Defective
8.6.1		
Power ON lamp	(i) Mains input fuse and switching	FS1 SW1
	(ii) Bridge Rectifier MR1 - MR4	MR1 - MR4
	(iii) Mains Transformer	T1
	(iv) Lamp	LP1
8.6.2		
Sync Output	(i) +5·4 volts DC	D13, etc.
	(ii) Period Multivibrator	IC A (Q4 & Q5)
	(iii) Shaper A	IC B (B1 & B2)
	(iv) Sync Output Amplifier	Q6
8.6.3		
Channel A Positive Output	(i) +17 volts DC	Q15, etc.
	(ii) +5·4 volts DC	D13, etc.
	(iii) Channel A Output Amplifier	Q11, 12, 13, 14
	(iv) Shaper/Width A	IC C
	(v) Shaper/Delay A	IC D (D1)
	(vi) Mixer	IC B
	(vii) Period Multivibrator	IC A (Q4 & Q5)
8.6.4		
Channel A Positive Output Combined (A+B)	As above but in addition:	
	(viii) Mixer/Delay B	IC D (D1, D3, D4)
	(ix) Shaper/Width B	IC E
	(x) Combine Switch (A+B)	SW6

1. Check Function	2. Circuit Tested	3. Test If Defective
8.6.5		
Channel B Positive Output	(i) +17 volts DC	Q15 etc.
	(ii) +5·4 volts D C	D13 etc.
	(iii) Channel B Output Amplifier	Q7, 8, 9, 10
	(iv) Shaper A	IC B (B1 & B2)
	(v) Shaper/Width B	IC E
	(vi) Mixer/Delay B	IC D (D2, D3, D4)
	(vii) Period Multivibrator	IC A (Q4 & Q5)
8.6.6		
Channel B Positive Output combined (B+A)	(viii) Delay A	IC B (B3 & B4)
	(ix) Shaper/Width A	IC C
	(x) Combine Switch (B+A)	SW7
8.6.7		
PG-71N only	(i) −17 volts	
Channel B Negative Output	(ii) +5·4 volts	D13 etc.
	(iii) Channel B Negative Output Amplifier	
	(iv) Shaper A	IC B (B1 & B2)
	(v) Shaper/Width B	IC E
	(vi) Mixer/Delay B	IC D (D2, D3, D4)
	(vii) Period Multivibrator	IC A (Q4 & Q5)
	(viii) Polarity Switch Negative	
8.6.8		
PG-71N only	As above but in addition:	
Channel B Negative Output combined (B+A)	(ix) Delay A	IC B (B3 & B4)
	(x) Shaper/Width A	IC C
	(xi) Combine Switch (B+A)	SW7
8.6.9	(i) Period Range Switch Contact 1	SW1
Manual Push Button	(ii) Manual Push Button	PB1
	(iii) Shaper/Delay A	IC B
	(iv) Mixer/Delay B	IC D
	(v) Shaper/Width A	IC C
	(vi) Shaper/Width B	IC E
	(vii) Output Channel A	Q11, 12, 13, 14
	(viii) Output Channel B	Q7, 8, 9, 10
8.6.10		
Ext Trigger	As above but in addition:	
	(ix) Ext Input Amplifier	Q1
8.6.11		
Ext Gate	(i) Gate Input Amplifier	Q2 & Q3
	(ii) Shaper/Delay A	IC B
	(iii) Mixer/Delay B	IC D
	(iv) Shaper/Width A	IC C
	(v) Shaper/Width B	IC E
	(vi) Output Channel A	Q11, 12, 13, 14
	(vii) Output Channel B	Q7, 8, 9, 10.
	(viii) Period Multivibrator	IC A (Q4 & Q5)

SECTION 9

DIAGRAMS

9.1 — COMPONENT LAYOUT — PG-71

9.2 — CIRCUIT DIAGRAM — PG-71

9.3 — CIRCUIT DIAGRAM — PG-71N NEGATIVE OUTPUT BOARD

9.4 — COMPONENT LAYOUT — PG-71N NEGATIVE OUTPUT BOARD

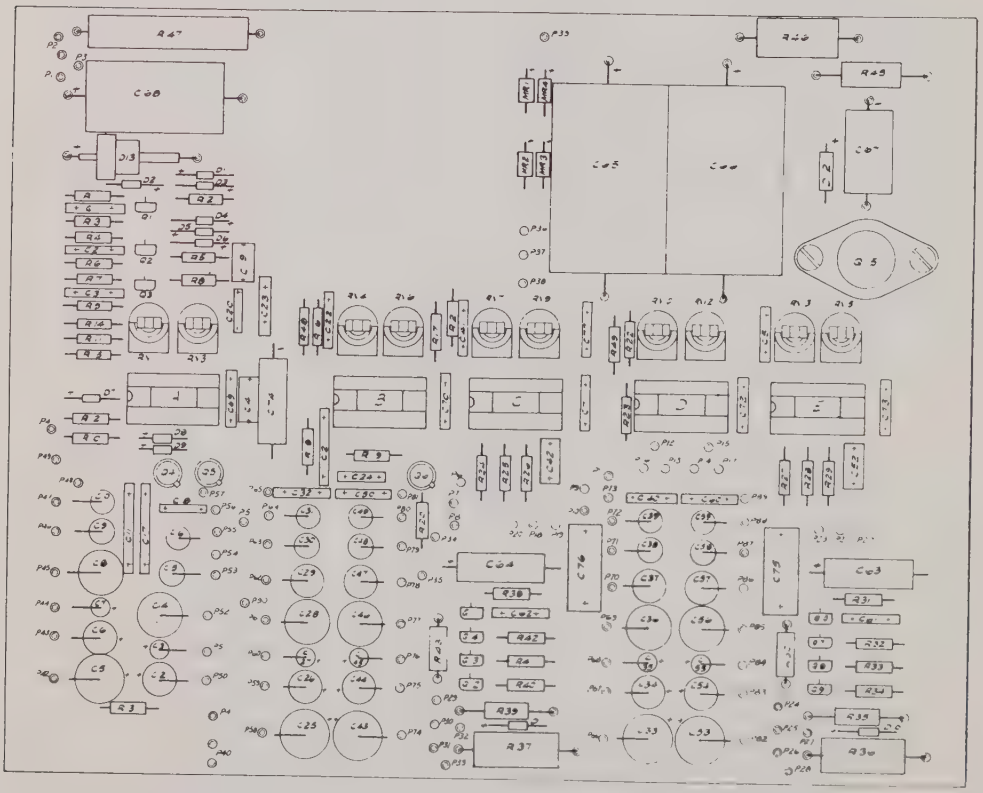
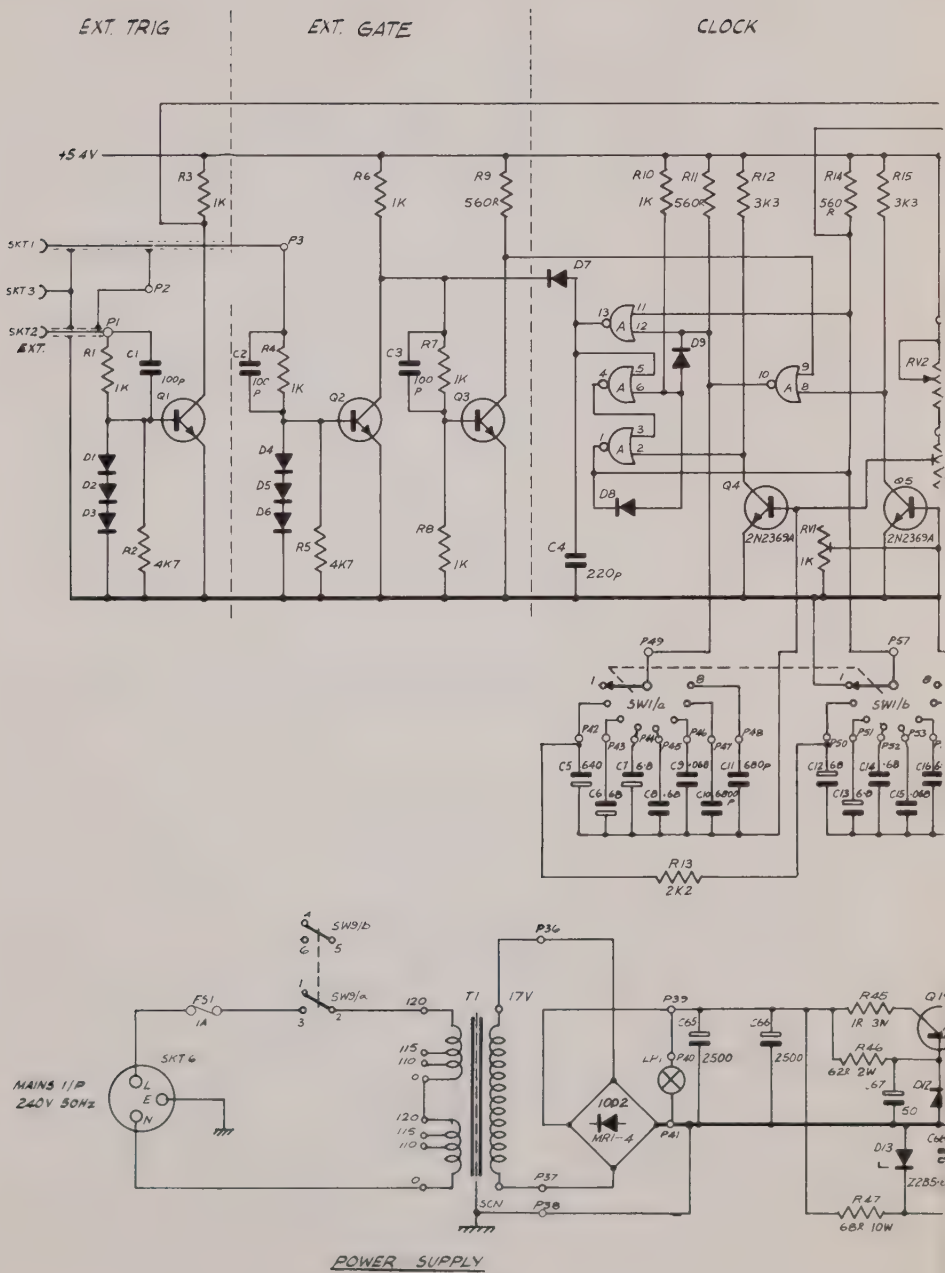
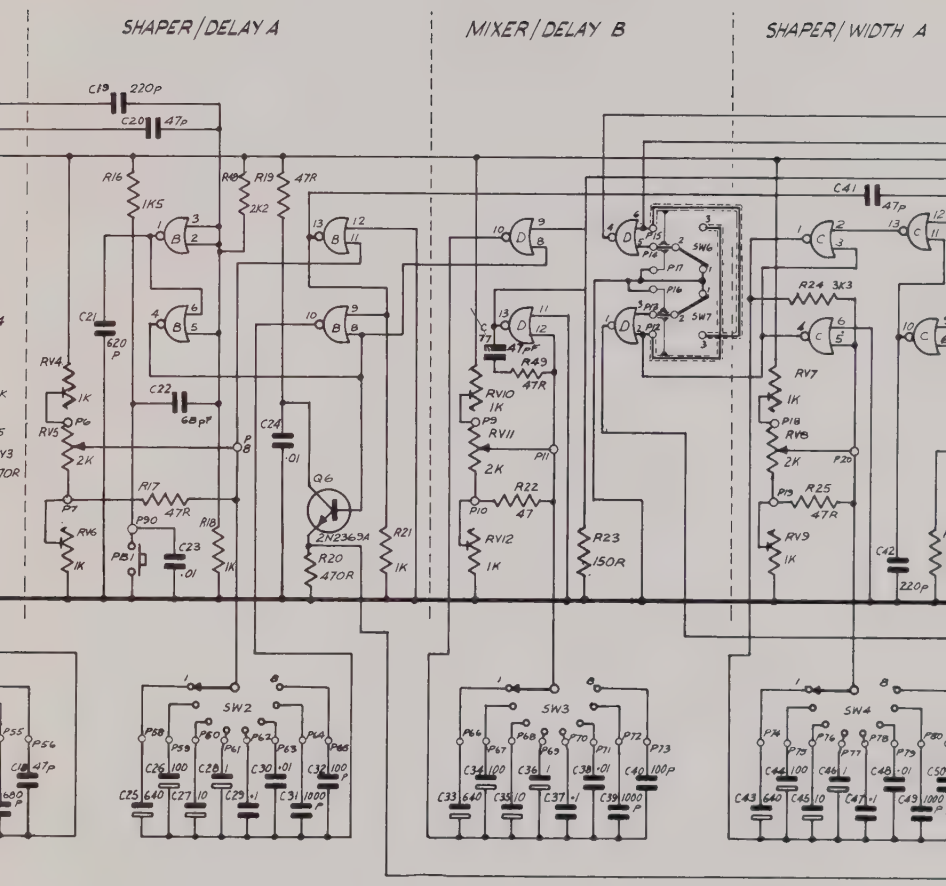


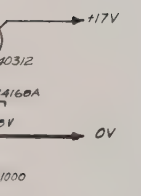
FIG. 9.1 — COMPONENT LAYOUT — PG-71

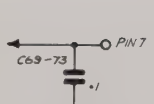

EXT. TRIG
EXT. GATE
CLOCK
+5.4V
R3 1K
R6 1K
R9 560R
R10 1K
R11 560R
R12 3K3
R14 560R
R15 3K3
SKT1
SKT3
SKT2
EXT.
P1
P2
P3
C1 100p
C2 100P
C3 100P
R1 1K
R4 1K
R7 1K
R8 1K
R2 4K7
R5 4K7
Q1
Q2
Q3
D1
D2
D3
D4
D5
D6
D7
D8
D9
C4 220p
Q4 2N2369A
Q5 2N2369A
RV1 1K
RV2
P49
P57
SW1/a
SW1/b
C5 .64
C6 .68
C7 .68
C8 .68
C9 .068
C10 680p
C11 680p
C12 .68
C13 .68
C14 .68
C15 .068
C16
R13 2K2
SW9/b
SW9/a
FS1 1A
SKT6
MAINS I/P 240V 50Hz
T1
120
115
110
0
17V
P36
P37
P38
SCN
P39
P40
P41
1002 MR1-4
C65 2500
C66 2500
LP1
R45 1R 3W
R46 62R 2W
C67 .67
D12
C68 50
D13
Z285
R47 68R 10W
POWER SUPPLY



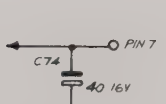
NOTE:-

1) ALL RESISTOR
2) ALL CAPACITO
3) ALL DIODES
4) ALL TRANSISTOR
5) ALL INTEGRATE
6) RV2, RV6, RV
7) SW1, SW2, SW
8) SKT7, SKT8
9) SKT1, SKT2



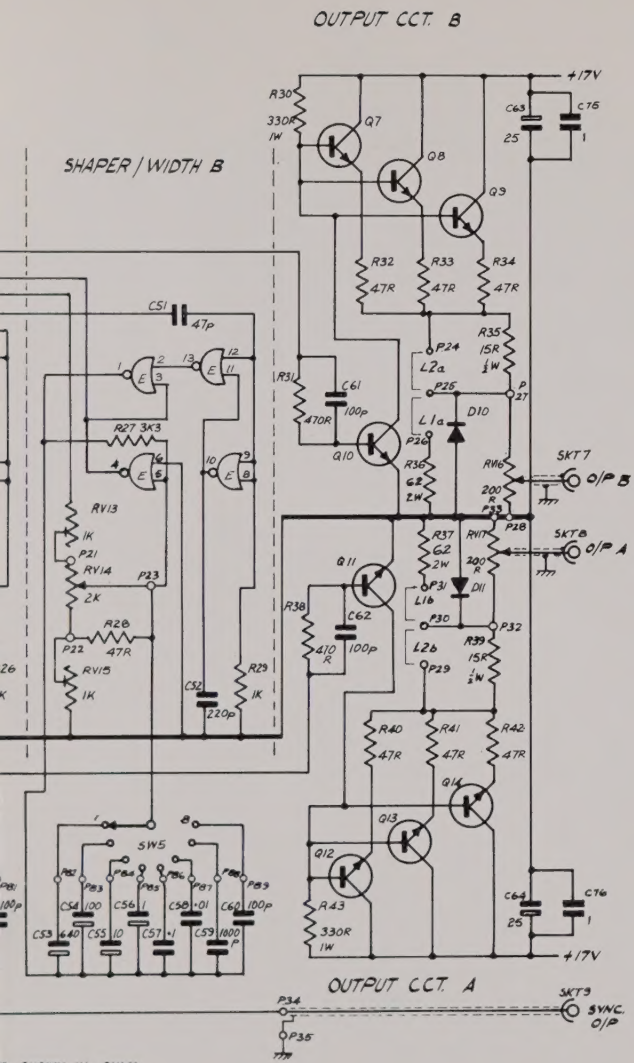


I.C. SUPPLY
(A – E)



I.C. SUPPLY
(A ONLY)

CLOCK	SHAPER/DE
RV1 SET MAX	RV4 SET
RV2 PERIOD	RV5 DELA
RV3 SET MIN	RV6 SET



S SHOWN IN OHMS

Zb SHOWN IN µF. UNLESS OTHERWISE INDICATED.

N916 UNLESS OTHERWISE INDICATED

8 ZTX314 UNLESS OTHERWISE INDICATED

D CCT's SN7402N

, RV11, RV14, RV16, RV17. MOUNTED ON FRONT PANEL

, SW4, SW5, SW6, SW7, SW9 & PB1 MOUNTED ON FRONT PANEL

SKT9 MOUNTED ON FRONT PANEL

SKT3, FS1 MOUNTED ON REAR PANEL.

POTENTIOMETER FUNCTION				
LAY A / MIXER / DELAY B	SHAPER / WIDTH A	SHAPER / WIDTH B	OUTPUT CCT A & B	
MIN.	RV10 SET MIN.	RV7 SET MIN.	RV13 SET MIN.	RV16 OUTPUT B
Y A	RV11 DELAY B	RV8 WIDTH A	RV14 WIDTH B	RV17 OUTPUT A
MAX.	RV12 SET MAX.	RV9 SET MAX.	RV15 SET MAX.	

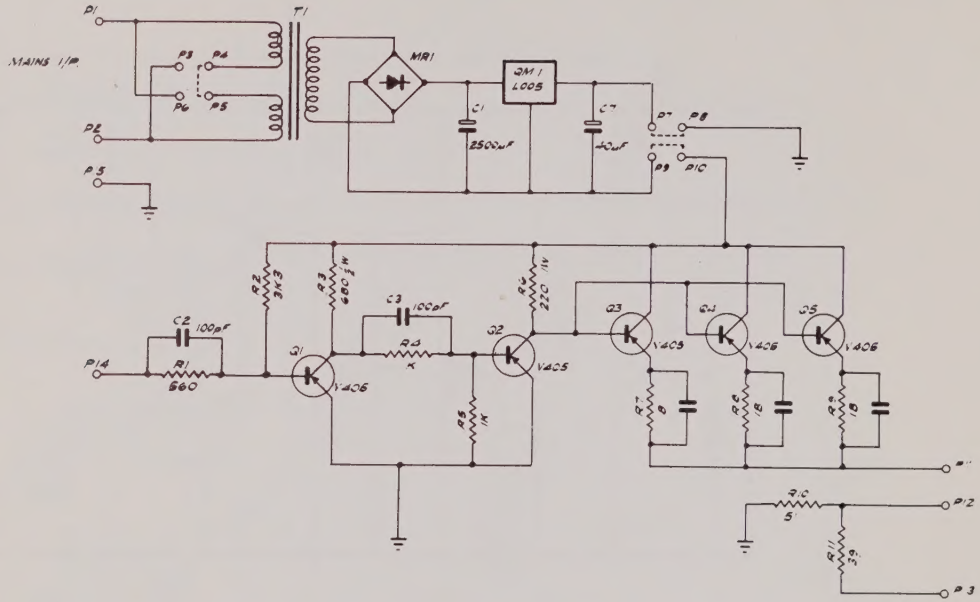


FIG. 9.3 — CIRCUIT DIAGRAM — PG-71N NEGATIVE OUTPUT BOARD

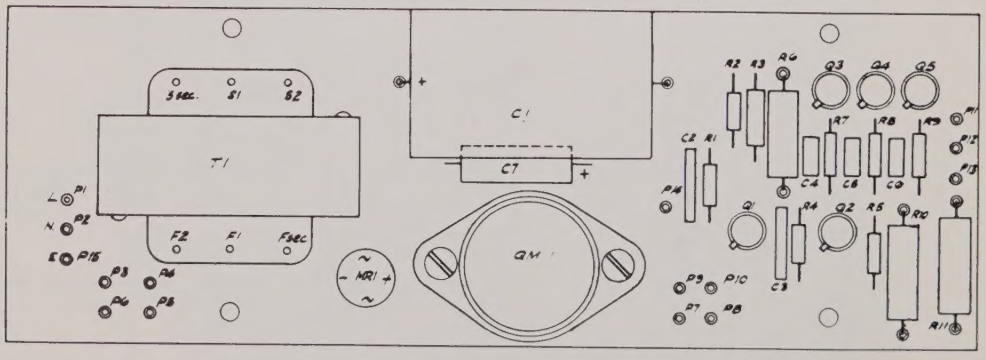


FIG. 9.4 — COMPONENT LAYOUT — PG-71N NEGATIVE OUTPUT BOARD

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